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GNSS - AUSTRALIAN RAIM PREDICTION SERVICE

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SUMMARY

This paper provides advice on the Australian Global Positioning System (GPS) Receiver Autonomous Integrity Monitoring (RAIM) Prediction Service which, with the assistance of the *United States Department of Transportation's Volpe Research Centre*, was successfully commissioned during July 1998. An opportunity for other States to consider seeking access to this system, under agreed commercial arrangements, to support their current or future GPS operational approvals, is also outlined.

1. Introduction

1.1 When “supplemental means” GPS non-precision approaches (NPAs) were first implemented in Australia in January 1998, the provision of an “aerodrome specific” RAIM Prediction Service was not regarded as being a pre-requisite to the implementation of such

an approval. Rather, Airservices Australia and the Australian Civil Aviation Safety Authority (CASA) considered this new service to be an additional pre-flight planning service for the aviation industry.

1.2 The Australian GPS RAIM Prediction Service is currently limited to the approach phase of flight. However, during late October 1998, Airservices and CASA, in conjunction with the aviation industry and neighbouring States, such as Fiji and New Zealand, will assess the performance of this system and decide whether, for example, the scope should be extended to include an en route RAIM Prediction Service. This assessment will also be used to assist in determining whether the implementation of “primary means” GPS non-precision approaches is feasible or not.

2. Overview

2.1 The availability of GPS for a pilot to conduct a non-precision approach is based on RAIM. The availability of RAIM is determined by the number and geometry of satellites visible to a user at a given location and is therefore predictable.

2.2 The purpose of the Australian GPS RAIM Prediction Service is to provide information about aerodrome-specific GPS outages to pilots during the pre-flight planning process and to provide similar notification to Air Traffic Services. On receipt of GPS outage information that conflicts with the planned arrival time, a pilot could consider options such as amending departure to the aerodrome in question to avoid the outage, or carry additional contingency fuel and depart on schedule. If however, at pre-flight planning, no GPS outages are predicted during the pilot’s scheduled time of arrival at this aerodrome then the flight could proceed as planned, in accordance with local regulatory requirements.

2.3 The GPS RAIM prediction function in a GPS receiver uses stored almanac data but does not take into account short-term satellite outages. This new pre-flight planning service overcomes this limitation.

2.4 The algorithm used for the GPS RAIM prediction system is based on the same requirements as the algorithm contained in an aircraft’s GPS receiver. To enable the GPS RAIM prediction system to compute RAIM availability, the system downloads the satellite almanac data from an Airservices GPS receiver. This almanac data provides the precise position of all orbiting satellites and is downloaded at least once per day. Should Airservices’ GPS receiver fail, the United States Coast Guard Internet Web page is used as a back-up.

2.5 Notices of any scheduled or unscheduled GPS satellite outages, known as Notice Advisories to NAVSTAR Users (NANU), are received via the Aeronautical Fixed Telecommunications Network (AFTN). Both the Almanac and NANU data are required by the RAIM algorithm to generate GPS outage data.

3. RAIM Outage Information

3.1 RAIM outage information is only currently provided for aerodromes with a published GPS approach. These locations are held in a database associated with the RAIM prediction system. If necessary, the system will alert the user that a GPS approach is not available for a particular aerodrome and hence a prediction will not be supplied.

3.2 The GPS RAIM prediction system is located in the Australian International NOTAM Office in Brisbane. Prediction information is ingested into the Airservices National Aeronautical Information Processing System (NAIPS) for access by pilots and Air Traffic Service staff in the Briefing Offices in Brisbane and Melbourne, and by staff in the Air Traffic Services Centres.

3.3 GPS RAIM predictions for non-precision approaches are also transmitted to ATS Centres, as required, via the AFTN, and dispatched to Airservices' Internet Web server. (<http://www.airservices.gov.au>).

3.4 RAIM outage data for all aerodromes in the database is computed once per day or when a satellite outage NOTAM has been received. This computation is for the following 48 to 72 hour period (the default is to predict for a 72 hour period). Once the computation is finished, outage data is made available through request/replies via NAIPS, and is also disseminated via the AFTN connection to the briefing offices, Web Server and ATS units.

3.5 In the case of NAIPS, when the RAIM outage data is received from the GPS RAIM prediction system, NAIPS formats the next 48 hours of data from the time of the request for distribution to the pilot. This information is presented as:

YGLB
 08231604 TIL 08231633
 08241600 TIL 08241629
 GPS RAIM UNAVBL FOR NPA
 or
 YBBN
 NO GPS RAIM OUTAGES

4. RAIM Availability Data Transfer and Message Format via the AFTN and Internet

4.1 RAIM availability information is distributed using the AFTN. RAIM messages are sent once per day at 1400 UTC, or when there is a change to the constellation status. In Australia, notification of RAIM outages for aerodromes is grouped by ATS Unit. In addition, these messages are distributed using a Pre-Determined Addressee Indicator (PDAI) to the Brisbane and Melbourne Briefing Offices.

4.2 The message format for notification of RAIM outages via the AFTN is:

```
GG YBBBXXXX YBBBPDAI
240010 YBBBRAIM
GPS RAIM PREDICTION 240010
YGLB
9802241600 TIL 9802241700
9802241800 TIL 9802241900
GPS RAIM UNAVBL FOR NPA

YTEM
NO GPS OUTAGES

YPAD
0902241510 TIL 9802241530
GPS RAIM UNAVBL FOR NPA
```

4.3 When this type of message is sent to the Web Server, the message content includes the common heading, the individual text for each location, and the database entry against each location.

4.4 In this situation, a pilot requesting RAIM information for Goulburn via the Internet would receive the following:

```
GPS RAIM PREDICTION 240010
YGLB
9802241600 TIL 9802241700
9802241800 TIL 9802241900
GPS RAIM UNAVBL FOR NPA
```

4.5 GPS RAIM information may also be requested by correctly formatted AFTN request message to NAIPS (YBBBZEXX).

4.6 An example of the format for an AFTN request message is:

```
GG YBBBZEXX
230410 (originator indicator)
REQ RAIM YGLB, YTEM, YPAD
```

4.7 Up to twenty (20) locations may be included in one request message. Each location must be separated by a comma.

5. Pilot Request for GPS RAIM Availability

5.1 Pilots may request the availability of GPS RAIM during the pre-flight planning stage by either direct access to electronic briefing aids (AVFAX), NAIPS, via the Internet (<http://www.airservices.gov.au>), by pilot briefing or through contacting the Airservices briefing offices.

6. Incorporation of Aerodrome Data into the GPS RAIM Prediction System

6.1 The GPS RAIM prediction system requires a database of aerodromes. The information for each aerodrome consists of the airport identifier and the latitude and longitude for the aerodrome. This database only contains a record of those aerodromes with published GPS non-precision approaches. The aerodrome database is updated as new GPS non-precision approaches are approved and published.

6.2 To date, twenty-four (24) GPS non-precision approaches have been approved and published in the Australian Aeronautical Information Publication for IFR use. A further fifty are in varying stages of production and should be implemented during the final quarter of 1998.

7. Provision of GPS RAIM Prediction Information to other States

7.1 Fiji and New Zealand are currently participating in a joint operational trial with Australia to assess whether the performance and scope of this service is adequate to support their current and future GPS approvals. Fiji and New Zealand have provided the required aerodrome information. This has been loaded into the RAIM prediction system database to facilitate this trial.

7.2 A unique opportunity therefore exists for these States and others in the Asia/Pacific Region to efficiently and cost effectively source GPS outage information direct from the Australian RAIM Prediction Service. Such an approach could avoid the need to outlay significant capital expenditure on the required hardware and software infrastructure of such a system.

7.3 The Australian GPS RAIM prediction system has the capacity to accommodate a large number of aerodrome locations. Other States may wish to consider seeking access to the Australia GPS RAIM Prediction Service, under agreed commercial arrangements, to support their current and future GPS approvals.

8. Recommendation

8.1 That the meeting note the information presented on the only GPS RAIM Prediction Service currently available in the Asia/Pacific Region.